IN THE CLAIMS

Please amend the claims as indicated below.

Claims 1-10. (Cancelled)

11 .(Currently Amended) ~~A method for tracking motion of a face comprising the steps of:~~

~~determining the calibration parameter of a camera;~~

~~marking salient features of an object with markers for motion tracking;~~

~~acquiring a plurality of initial 2-D images of the object;~~

~~calculating 3-D locations of the salient features of the object in accordance with the calibration parameter of the camera;~~

~~receiving a chronologically ordered sequence of 2-D images of the object;~~

~~storing or transmitting tracked motion of the object.~~

A method for tracking motion of a face comprising the steps of:

determining the calibration parameter of a camera;

marking salient features of an object with markers for motion tracking;

acquiring a plurality of initial 2-D images of the object;

calculating 3-D locations of the salient features of the object in accordance with the calibration parameter of the camera;

calculating 3-D locations of the global and local markers in the neutral state; and

calculating 3-D locations of the local markers in each action state;

receiving a chronologically ordered sequence of 2-D images of the object;

storing or transmitting tracked motion of the object,

calculating the 3-D locations of the local markers in each action state by estimating the orientation and position of the face in each 2-D image of the action state to conform to the 3-D and 2-D locations of the global markers under a perspective

projection model and calculating the 3-D locations of the local markers to conform to the estimated orientation and position of the face and the 2-D locations of the local markers under a perspective projection model.

12.(previously presented) The method of claim 11 further comprising the steps of:

locking onto the markers; and

detecting loss of lock and hence the need for re-locking onto the markers.

13.(previously presented) The method of claim 11 wherein the step of tracking comprises the steps of.

determining a surface normal for each salient features;

tracking motion of the markers on the object in each 2-D image; and

tracking the 3-D global motion of the markers on the object in each image; and

tracking the 3-D local motion of the markers on the object in each image.

14. (previously presented) The method of claim 12 comprising the further step of repeating the locking and tracking steps after the detecting step.

15. Cancelled.

16. Cancelled.

17. (previously presented) The method of claim 11 wherein a first set of markers identifies global motion and a second set of markers identifies local motion of the face.

18. (original) The method of claim 17 wherein the markers comprise at least two colors.

19. (original) The method of claim 18 wherein the two colors are contrasting.

20. (original) The method of claim 19 wherein the colors are black and white.

21. (original) The method of claim 16 wherein the markers comprise two concentric circles of different colors.

22. (original) The method of claim 21 wherein the outer circle has a diameter at least twice the diameter of the inner circle.

23. (original) The method of claim 11 wherein the step of selecting comprises wearing a head-set with markers.

24. (original) The method of claim 23 wherein the head-set comprises a strap for a chin.

25. (original) The method of claim 23 wherein the head-set comprises a strap for eyebrows.

26. (original) The method of claim 23 wherein the head-set comprises at least one strap for a skull.

27. (original) The method of claim 11 wherein the acquired 2-D images include at least two views of the face with markers in a neutral state at different orientations;

28. (original) The method of claim 27 wherein the two views are orthogonal.

29. (original) The method of claim 11 wherein the acquired 2-D images comprise front, forehead, chin, angled-right, angled-right-tilted-up, angled-right-tilted-down, angled-left, angled-left-tilted-up, angled-left-tilted-down, full-right-profile, full-right-profiletilted-up, full-right-profile-tilted-down, full-left-profile, full-left-profile-tilted-up, and full-left-profile-tilted-down views of the face with markers in the neutral state.

30. (original) The method of claim 11 wherein the acquired 2-D images comprise front, forehead, chin, full-right-profile, and full-left-profile views of the face with markers in the neutral state.

31. (previously presented) The method of claim 11 wherein the acquired 2-D images include a plurality of views of the face with markers in at least one action state.

32. (original) The method of claim 31 wherein the action states of the face comprise smiling lips, kissing lips, yawning lips, raised eyebrows, and squeezed eyebrows.

33. (original) The method of claim 31 wherein the acquired 2-D images of the face in an action state include at least two views at different orientations.

34. (original) The method of claim 33 wherein the two views are front and angled-right.

35. Cancelled.

36. Cancelled. (previously presented) The method of claim 11wherein the step of calculating the 3-D locations of the markers comprises the steps of:

calculating the 3-D locations of the global and local markers in the neutral state; and calculating the 3-D locations of the local markers in each action state;

37. (Currently Amended) The method of claim 11 ~~36~~ wherein the step of calculating the 3-D locations of the global and local markers in the neutral state comprises the steps of:

calculating the 3-D locations of the markers to conform to their 2-D locations in the 2-D images of the face in the neutral state under an orthographic projection model;

calculating relative distances of the face to the camera in the 2-D images to conform to the 2-D locations of the markers and their calculated 3-D locations under a perspective projection model;

modifying the 2-D locations of the markers to conform to the calculated relative distances and the 3-D locations under a perspective projection model;

recalculating the 3-D locations of the markers to conform to their modified 2-D locations under an orthographic projection model;

repeating the steps of calculating the relative distances, modifying the 2-D locations, and recalculating the 3-D locations to satisfy a convergence requirement; and

translating and rotating the 3-D locations so that they correspond to a frontal-looking face.

38. Cancelled.

39. (original) The method of claim 13 wherein the step of tracking the 3-D global motion comprises the steps of:

predicting the location of global salient features in a 2-D image;

detecting global salient features in the 2-D image; and

estimating the 3-D global motion of the face in the 2-D image.

40. (original) The method of claim 39 wherein the step of predicting comprises calculating 2-D locations of the global salient features under a perspective projection model using the position and orientation of the face in a previous 2-D image, and the step of detecting comprise detecting the global markers.

41. (original) The method of claim 40 wherein detecting the global markers comprises:

determining visibility indices of global markers;

designing correlation filters for the global markers;

detecting the global markers by applying elliptical correlation filters in a neighborhood of the global markers; and

eliminating superfluous and multiple detected locations.

42. (previously presented) The method of claim 40 wherein the step of estimating the 3 D global motion comprises calculating the position and orientation of the face to conform to the 3D locations and the detected locations of the global markers under a perspective projection model.

43. (original) The method of claim 13 wherein the step of tracking the 3-D local motion comprises the steps of:

predicting the location of local salient features;

detecting local salient features; and

estimating the 3-D local motion of the face.

44. (original) The method of claim 43 wherein the local markers are placed on eyebrows and lips.

45. (original) The method of claim 44 wherein the locations of the local markers comprise proximate ends of the eyebrows, corners of the lips, and the upper and lower centers of each lip.

46(previously presented) The method of claim 45 wherein the step of predicting the locations of local markers comprises calculating the locations of the local markers using the position, orientation, and action states of the face in a previous 2-D image and the step of detecting comprise detecting the local markers.

47. (previously presented) The method of claim 46 wherein detecting the local markers comprise:

determining visibility indices of local markers;

designing correlation filters for the local markers;

detecting the local markers by applying elliptical correlation filters in a neighborhood of the local markers; and

eliminating superfluous and multiple detected locations.

48. (previously presented) The method of claim 47 wherein the step of estimating comprises:

finding 3-D locations of local markers to conform to the detected 2-D locations of the local markers;

calculating an action vector representing the weights of the facial actions in the 2-D image conforming to the found 3-D locations of the local markers and the 3-D locations of the local markers for the neutral and the action states under a perspective projection model.

49. (original) The method of claim 48 wherein the step of calculating an action vector comprises the steps of:

calculating the difference between the 2-D locations of the local markers detected in an image and the 2-D locations of the same markers corresponding to the neutral face;

modifying the difference to conform to the orthographic projection;

calculating the 3-D displacements of the local markers with respect to their location in the neutral face; and

calculating the amount of facial actions conforming to the 3-D displacements of the local markers.

50. (original) The method of claim 48 wherein the step of calculating an action vector comprises the steps of:

calculating the 2-D locations of the local markers corresponding to the neutral face using the global motion found for the current image;

calculating the 2-D locations of the local markers corresponding to the action faces using the global motion found for the current image;

calculating the distance between the detected locations, the distance between the neutral locations, and the distance between the action locations of the markers at the right and left corners of the lips;

calculating the distance between the detected locations, the distance between the neutral locations, and the distance between the action locations of the markers at the upper and lower center of lips;

calculating the distance between the detected locations, the distance between the neutral locations, and the distance between the action locations of the markers at the proximate ends of the eyebrows;

determining the fractional displacements of the local markers for the lips area and for the eyebrows area; and

determining action mode and amount for the lips area and for the eyebrows area based on the fractional displacements of the local markers.

51. (Currently Amended) ~~A method for tracking motion of an object in a chronologically ordered sequence of 2-D images of the object comprising the steps of:~~

~~selecting global and local salient features of the object for tracking by fixing markers to the object;~~

~~calculating 3-D locations of the markers at the global and local salient features for a neutral state of the object, and calculating 3-D locations of the local salient features for action states of the object;~~

~~predicting 2-D locations of the markers at the global and local salient features in a 2-D image;~~

~~detecting 2-D locations of the markers at the global and local salient features in the 2-D image; and~~

~~estimating the global and local motion of the object in the 2-D image.~~

A method for tracking motion of an object in a chronologically ordered sequence of 2-D images of the object comprising the steps of:

selecting global and local salient features of the object for tracking by fixing markers to the object;

calculating 3-D locations of the markers at the global and local salient features for a neutral state of the object, and calculating 3-D locations of the local salient features for action states of the object;

calculating the 3-D locations of the global and local markers in a neutral state; and

calculating the 3-D locations of the local markers in each action state by estimating the orientation and position of the face in each 2-D image of the action state to conform to the 3-D and 2-D locations of the global markers under a perspective projection model and calculating the 3-D locations of the local markers to conform to the estimated orientation and position of the face and the 2-D locations of the local markers under a perspective projection model;

predicting 2-D locations of the markers at the global and local salient features in a 2-D image;

detecting 2-D locations of the markers at the global and local salient features in the 2-D image; and

estimating the global and local motion of the object in the 2-D image.

52. (original) The method of claim 60 where the action states of the object define maximum local motions of the object.

53. (previously presented) The method of claim 61 where the method of calculating comprises:

acquiring a plurality of initial 2-D images of the object in neutral state;

acquiring a plurality of initial 2-D images of the object in action states identifying the 2-D locations of the salient features in each initial 2-D image;

estimating the orientation and position of the object in each initial 2-D image to conform to the 2-D locations of the salient features under a perspective projection model; and

calculating 3-D locations of the salient features to conform to the 2-D locations of the salient features under a perspective projection model.

54. Cancelled.

55. (previously presented) The method of claim 63 wherein a first set of markers define global salient features and a second set of markers define local salient features.

56. (previously presented) The method of claim 63 wherein the step of estimating global motion comprises calculating 3-D position and orientation of the object to conform to the 3-D locations of the global markers in the neutral state and the detected 2-D locations of the global markers under a perspective projection model.

57. (previously presented) The method of claim 63 wherein the step of estimating local motion comprise calculating a vector of weights representing fractions of maximum actions of the object conforming to the 3-D locations of local markers in the neutral and action states and the
detected 2-D locations of the local markers under a perspective projection model.

58. (previously presented) The method of claim 60 wherein the object is a face.

59. (previously presented) The method of claim 63 wherein the markers comprise concentric circles with two contrasting colors.

60. (previously presented) The method of claim 68 wherein the step of detecting comprises applying elliptical correlation filters in a neighborhood of the markers.